

BELLCOMM, INC.

SUBJECT: On-Pad Crew Safety: Modifications
to Operations and Hardware to
Improve Crew Escape Times -
Case 320

DATE: March 3, 1967
FROM: P. R. Knaff

ABSTRACT

This memorandum is an outgrowth of a request to the Apollo Saturn Crew Safety Panel to comment on some MSC recommendations concerning the Umbilical Tower Access Arm and the Environmental Chamber. The Panel decided to respond in terms of general guidelines. In accordance with this philosophy, it was proposed that the Panel recommend that: 1) solutions dealing with on-pad hazards and emergencies be directed to preserving, as far as possible, the simultaneous availability of both a LES abort and emergency egress as escape options, and 2) time-compatibility should be a major criterion in evaluating proposed modifications to allow rapid crew egress. This memorandum briefly develops the rationale behind these recommendations and notes some implications for hardware and operational changes.

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MODIFICATIONS TO OPERATIONS AND HARDWARE TO
IMPROVE CREW ESCAPE TIMES (Bellcomm, Inc.)
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MEMORANDUM FOR FILE

The most recent Apollo/Saturn Crew Safety Panel meeting was held at MSC on February 28, 1967. Although the AS-204 fire was not discussed directly, the Panel was requested to comment on some MSC recommendations concerning the Umbilical Tower (UT), Access Arm (AA), and the Environmental Chamber (EC). The Panel decided to emphasize general guidelines. In line with this philosophy, this author submitted two paragraphs to the co-chairmen to be used as candidate recommendations from the Crew Safety Panel:

With respect to on-pad hazards and emergencies, the Panel recommends that proposed solutions are directed to preserving, as far as possible, the simultaneous availability of both a LES abort and an emergency egress as escape options.

Secondly, the Panel recommends that time-compatibility [between escape-route elements] should be a major criterion in evaluating proposed modifications to the CM and to pad hardware to allow rapid crew egress.

This memorandum briefly develops the reasoning behind the recommendations above, and notes some of the implications for hardware and operational changes.

Two major categories of emergencies exist: 1) those requiring rapid crew evacuation from the CM and 2) those requiring a rapid escape from the area of the booster. In those cases where both avenues of crew escape cannot be simultaneously present, the speed of reestablishing them is a good criterion for evaluating alternate solutions.

A quick-opening hatch has been proposed which will permit the crew to have a CM exit established in two seconds. In order to utilize this escape route, however, the access arm must be available. If the AA is fully withdrawn, it takes between 35 and 50 seconds, approximately, to reestablish that egress route.

A rapid LES abort capability should also be preserved. If the AA is attached to the CM, approximately 15 seconds are required to unlatch and swing the AA clear of the CM. In reviewing the circumstances surrounding the 503 S-IVB explosion, the Crew Safety Panel found that approximately two seconds would have been available for the crew to initiate a LES abort and escape safely.

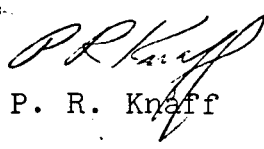
In order to summarize the time relationships between the two escape paths and selected pre-launch configurations, Table 1 shows the time delays that are associated with initiating crew escape. On-pad configurations have been specified in terms of AA position, Closeout Crew gross location, and CM hatch position. For each configuration, the delays have been shown both for initiating LES abort and for CM evacuation and in each case, the pacing item is included. When the hatch is closed, abort must be delayed by a time ($\sim 20 - 60$ seconds) to get the Closeout Crew to an area offering protection from the LES rocket plume. Once the AA is clear of the CM, the only delay to LES initiation would be flight crew reaction time (~ 1 second).

Turning to emergency egress, crew reaction time is the only pacing item when the hatch is open and, even with the hatch closed, only two to three seconds are required to reestablish this route if a new hatch design is adopted and if the AA is available. Once the AA has been drawn free of the CM, its reattachment becomes the pacing item. Even if the AA is positioned just clear of the CM, rather than fully retracted, approximately 20 - 30 seconds are required for reattachment.

With currently planned hardware, the least hazardous of pre-launch configurations occurs with the hatch closed, the Closeout Crew off the UT, and the AA either 1) latched to the CM or 2) positioned just clear of the CM. If the AA is latched, (case 1), LES abort is delayed 15 to 20 seconds, and the crew would be vulnerable to an on-pad incident like the 503 explosion. If the AA is held just clear of the CM (case 2), 20 to 30 seconds would be required to establish an emergency egress route. This configuration would not allow the rapid escape from the CM that the SA-204 accident would have required.

This assessment leads to examining alternative hardware modifications, one of which would use a break-away or swing-away lightweight structure to bridge the gap from the CM to the AA, when the AA is positioned just clear of the CM. As indicated in Table 1, this structure would not delay initiating a LES abort or an emergency egress. The attractiveness of such modifications, in terms of improved on-pad crew safety, leads to the recommendation that they be explored further.

1025-PRK-mm


P. R. Knoff

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CONFIGURATION ON PAD

ACCESS ARM		LATCHED TO CM		UNLATCHED, CLEAR OF CM GAP BRIDGED	UNLATCHED, FULLY RETRACTED
CLOSE OUT CREW		ON UT		OFF UT	
CM HATCH		CLOSED			
TIME DELAY TO INITIATE	LES ABORT	NOT AVAILABLE	~20 - 60 SEC CLOSEOUT CREW TO PROTECTION FROM LES PLUME*	~15 SEC AA TO UNLATCH AND CLEAR CM	~1 SEC CREW REACTION TIME
	CM EVACUATION	~1 SEC CREW REACTION TIME	~2 - 3 SEC HATCH OPENING**	~2 - 3 SEC HATCH OPENING	~20 - 30 SEC AA CLOSE GAP AND LATCH
					~35 - 50 SEC AA TRAVERSE TO CM & LATCH

*SEE TEXT

**ASSUMES PROPOSED QUICK-RELEASE HATCH

TABLE 1. RELATIONSHIP BETWEEN SELECTED ON-PAD CONFIGURATIONS AND TIME DELAYS TO INITIATE FLIGHT CREW ESCAPE.
Cell entries show approximate time delay and pacing item.